ECE 4670 Lab Report Grading and Hints

Lab 1: Signals and Systems Analysis and Measurements

Points	Lab Exercise Number	Laboratory Exercise Description	Check off
	Problem 1	**Basic Spectrum Analyzer Measurements and Theoretical calculation of a sinusoid signal**	
5		**Derive the theoretical** values for input sinusoid at 1 $V_{\text{p-p}}$, in both V_{rms} and dBm relative to a 50Ω system.	
5		For your chosen frequency **Measure** values the spectrum amplitude of the sinewave in dBm. Be sure note that the time domain amplitude is as desired on the scope when using a 50Ω termination.	
	Problem 2	**Basic Spectrum Analyzer Measurements and Theoretical calculation of a square and triangle wave signal**	
10	Part a	**Derive the theoretical** values of the spectrum of a square-wave at $1V_{\text{p-p}}$ in dBm, for at least 10 harmonics, show your work (this can be done directly in Python using a for loop). Identify theoretically at what frequencies spectral lines should be present. (Show work using Fourier Analysis; see the Python code in the sample notebook under Square and Triangle Wave Expansions to get started; note `n = arange(1,Nmax,2)` creates an array stepping by 2, i.e., [1, 3, 5, 7, …]).	
5	Part a	**Measure** the values of spectrum of the square-wave 1 $V_{\text{p-p}}$ in dBm, for at least 10 harmonics. Compare to your theoretical values. Best done in a table or formatted list. Ask your instructor for ideas on how to do this in Python.	
10	Part b	**Derive the theoretical** values of the spectrum of triangle-wave 1 $V_{\text{p-p}}$ signal in dBm, for at least 10 harmonics, show your work. Identify theoretically at what frequencies power should be present. (Show work using Fourier Analysis)	
5	Part b	**Measure** values of spectrum of Square-wave 1 $V_{\text{p-p}}$ in dBm, for at least 10 harmonics. Compare to your theoretical values, Best done in a table or formatted list.	
	Problem 3	**Total Power in a square wave spectrum**	
10		**Derive the theoretical** values of the spectrum of a 10 MHz, -20 dBm (total power) square-wave signal. Using Fourier analysis calculate the power in the 1^{st}, 3^{rd} and 5^{th} harmonic (show your work using Fourier analysis). **Hint**: To set the proper signal amplitude you first need to find the average power in a square wave using the time average $< x^2(t) >$. Recall for periodic signals this is just integrating $x^2(t)$ over one period and dividing by the period. This will need to be done for a 50Ω system.	
5		**Measure** the values of the spectrum of a 10 MHz, -20 dBm (total power) square-wave signal; that is measure the power in the 1^{st}, 3^{rd} and 5^{th} harmonic. Compare to your calculated values in the first part, put into a table or printed list for comparison.	

	Problem 4	**Modeling Implementation Impairments for All 3 Filters**	
		(Note all of this must be done in Jupyter notebook, example is given in the lab zip file online)	
5		Modify code to import your 70 MHz BPF s2p file	
5		Modify code to implement "Ideal" 70 MHz BPF (for plotting)	
5		Modify code to implement Slider control of components	
5		Tweak component values with sliders to "line-up" measured value of s2p file and design component value result. List actual component values in a table (L , Q and C lumped elements) **Screenshot your results**	
5 bonus		Modify code to plot Group Delay (T_g) of this filter from the s2p file	
5		Modify code to import your 88-108 MHz BPF s2p file	
5		Modify code to implement "Ideal" 88-108 MHz BPF (for plotting)	
5		Modify code to implement Slider control of components	
5		Tweak component values with sliders to "line-up" measured value of s2p file and design component value result. List actual component values in a table (L , Q and C lumped elements) **Screenshot your results**	
5 bonus		Modify code to plot Group Delay (T_g) of this filter from the s2p file	
5		Modify code to import your 1 MHz LPF s2p file	
5		Modify code to implement "Ideal" 1 MHz LPF (for plotting)	
5		Modify code to implement Slider control of components	
5		Tweak component values with sliders to "line-up" measured value of s2p file and design component value result. List actual component values in a table (L , Q and C lumped elements) **Screenshot your results**	
5 bonus		Modify code to plot Group Delay (T_g) of this filter from the s2p file	
	Problem 5	**Band-Pass Filter Design**	
10		Design a 70 MHz BPF with 4 MHz wide pass band, like the design in the lab reader and code in found in the Jupyter notebook. List the ideal component values required.	
5		Using COTS component values (you can get close using series and parallel component selection but keep the total component count to a reasonable/small number), list values that are needed to implement this design.	
10		Compare the ideal theory and ideal lossless amplitude in dB versus frequency responses when using real L and C values (in the combinations you chose above).	
140		Total Points (15 bonus points available)	